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VOL. 18 PART 4

TRANSACTIONS

OF THE

SOCIETY FOR BRITISH ENTOMOLOGY

World List abbreviation: *Trans. Soc. Brit. Ent.*

CONTENTS.

F. K. KASULE

Field Studies on the Life-Histories of Some British Staphylinidae (Coleoptera)

DATE OF PUBLICATION, DECEMBER 1968.

Copies may be purchased from G. R. GRADWELL, Hope Department of Entomology, University Museum, Oxford

Price 16/- post free

Published for the Society
by the British Trust for Entomology Ltd.

THE BRITISH TRUST FOR ENTOMOLOGY

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REGISTERED ADDRESS—41 Queens Gate, London, S.W.7.

EDITORIAL—The Editor: Dr. E. J. Popham, Dept. of Biology, The University, Salford, Lancs.

Sub-Editors: Dr. R. R. Askew and Dr. J. H. Kennaugh, Dept. of Zoology, The University, Manchester 13.

SUBSCRIPTIONS, SALES and MEMBERSHIP—The Secretary, G. R. Gradwell, Hope Dept. of Entomology, University Museum, Oxford.

PUBLICATIONS

THE ENTOMOLOGIST. Published monthly, one volume per annum. Subscription rate 35/- per annum.

THE TRANSACTIONS OF THE SOCIETY FOR BRITISH ENTOMOLOGY. Published irregularly, one volume every two years. Subscription rate 30/- per annum.

Members of the Trust may subscribe to both periodicals at a combined subscription of 55/- per annum.

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TRANSACTIONS OF THE SOCIETY FOR BRITISH ENTOMOLOGY

VOL. 18 · DECEMBER 1968 PART IV

Field Studies on the Life-Histories of Some British Staphylinidae (Coleoptera)

By F. K. Kasule*
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Synopsis

An account is given of the relative abundance, locomotor activity and life-histories of several British Staphylinids. Four life-history types are distinguished and the relationship of these with locomotor activity is discussed.

Introduction

The family Staphylinidae is one of the largest amongst the Coleoptera. It includes more than 20,000 described species of which more than 800 are known from Britain. Most of the members of the Staphylinidae are, like the Carabidae, terrestrial predators and may ecologically be of equal importance.

Whereas quite a lot is known about the life-histories of British Carabidae (e.g. Larsson (1939), Lindroth (1945-59), Gilbert (1956), Greenslade (1965) and Penney (1965)), little is known about the life-histories of British Staphylinidae. In a study of the surface fauna of forests in Holland, Van der Drift (1959) described briefly the life-histories of a few Staphylinids some of which occur in Britain. This paper presents a field study on the life-histories of several species of British Staphylinidae. The study was carried out in Scotland during 1965 and 1966, at the Ross Peninsula on the eastern side of Loch Lomond, Stirlingshire.

The study area can be regarded as a mixed deciduous wood (mostly oak, *Quercus robur* L.) despite considerable numbers of recently planted conifers (*Picea abies* L. and *P. sitchensis* Bong.). Bracken, *Pteridium aquilinum* Kuhn., grew profusely in the more open parts of the study area.

Methods

From January, 1965 to December, 1966, twenty pitfall traps (1 lb. Kilner Jars) were laid in four rows of five each. The traps, 25 yards apart and covering a total area of 15,625 square yards were sunk into the ground until their rims were level with the soil surface. A mixture of six per cent. formaldehyde and glycerine

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was added and the traps were protected from rain and falling leaves by pieces of bark supported clear of the soil.

The catches, emptied weekly during summer and fortnightly at other times were brought to the laboratory and the numbers and stages of each species caught, recorded and preserved in seventy per cent. alcohol. The results from pitfall traps gave a measure of total population locomotor activity which of course depended on individual activity and the number present.

To obtain data on population fluctuations independent of activity, leaf litter samples were taken at regular intervals. These also provided data on some species or certain stages of species not caught by pitfall traps, e.g. *Stenus impressus*. From March, 1965 to December, 1966 thirty standard samples of leaf litter were taken at approximately weekly intervals in an area about 100 yards from the trapping area. (It was realised that there would be population differences between this area and the trapping area, but it was thought that the numbers of each species would show similar fluctuations in both areas). These samples represented the maximum number which could be handled with the apparatus available.

On each sampling occasion an aluminium quadrat of a total area 0·15 sq. yard, was placed randomly on the ground and driven into the soil. The tall walls of the quadrat (12 inches high) prevented movement of insects into and out of the area sampled. The leaf litter together with the grass inside the quadrat was scooped into polythene bags and transported to the laboratory where the samples were extracted in Berlese Funnels. The insects emerging were killed in Pampel's Fluid and the numbers and stages of the various species extracted were recorded and preserved. The efficiency of Berlese Funnels in extracting various species was not tested. Although bigger Staphylinids could, once in the Berlese Funnels, hardly escape extraction, it is probable that a few specimens of the small and agile species (e.g. *S. impressus*) might have escaped. Nevertheless, data on comparative numbers of species were obtained, but in many cases the numbers were too low or too variable to enable any information on population fluctuations to be obtained.

In order to get information on breeding seasons, samples of preserved females from pitfall traps and litter samples were dissected and examined for presence or absence of developing and mature eggs. This work was supported by collecting larvae from the field and rearing them to the adult stage. Also female beetles captured in the field were brought to the laboratory and allowed to lay eggs.

Results

A: Locomotor Activity in Some Staphylinidae

In fig. 1, records from pitfall traps are summarised showing the months when various species of adult Staphylinidae were

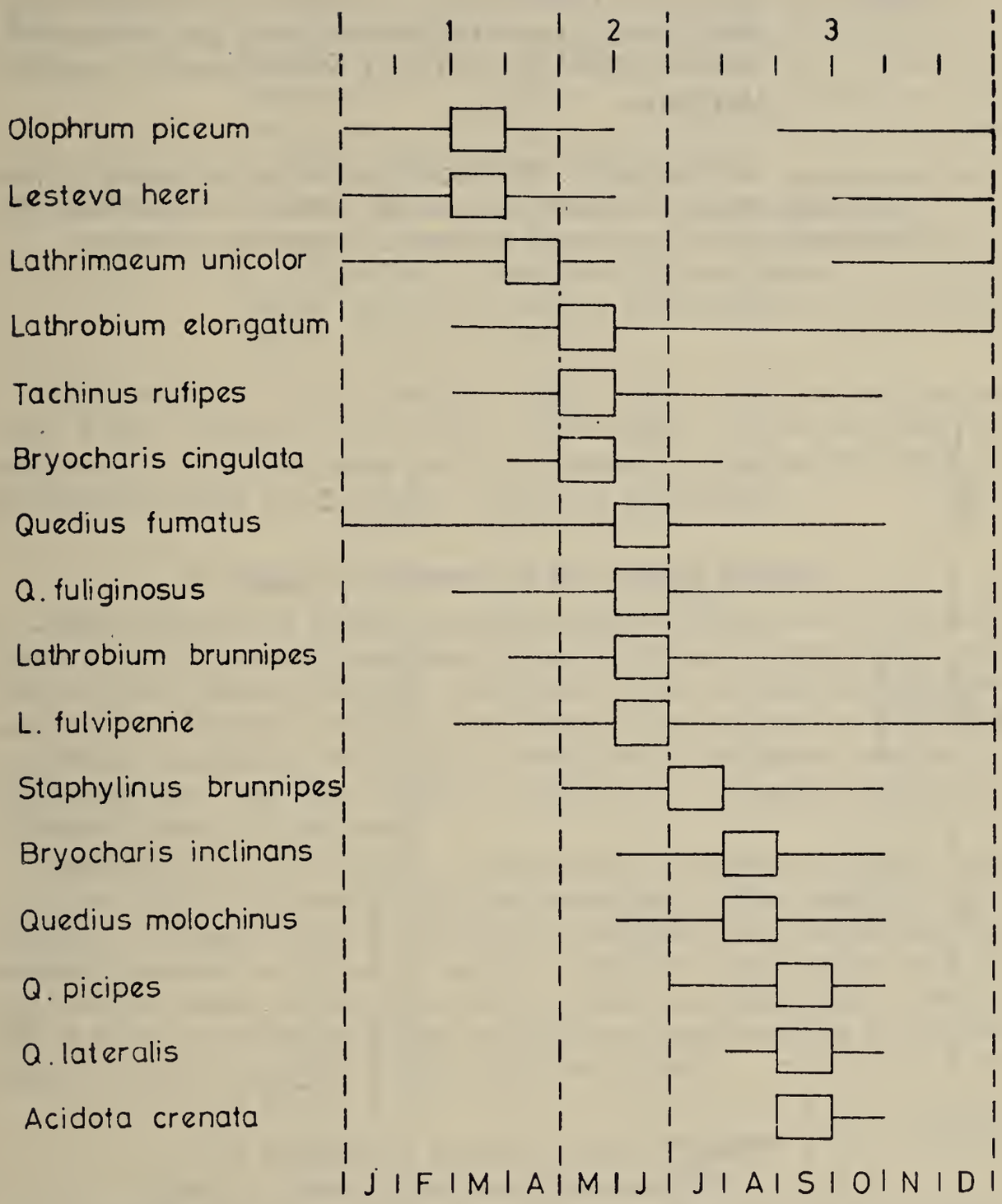

FIG. 1. Annual distribution of locomotor activity in some Staphylinidae from pitfall traps; horizontal lines: periods when species were frequent in traps; blocks: months of maximum catches

active. With the exception of *Othius* (*Gyrohypnus* auctt.) spp.* which were active throughout the year, locomotor activity of adult Staphylinidae studied at the Ross Peninsula was limited to a part of the year and the species fell into several groups according to the times of maximum activity. The maxima showed a succession throughout the year, but three seasonal groups of species are here distinguished:

*Not shown in the figure; observations on these species will be published elsewhere.

Group 1: Species with maximum numbers appearing during March and April—*Olophrum piceum* Gyllenhal**, *Lesteva heeri* Fauvel and *Lathrimaeum unicolor* Marsham.

**In this species the maximum immediately following emergence of the new generation is shown in order to bring it in line with the following two species since they have similar life-histories.

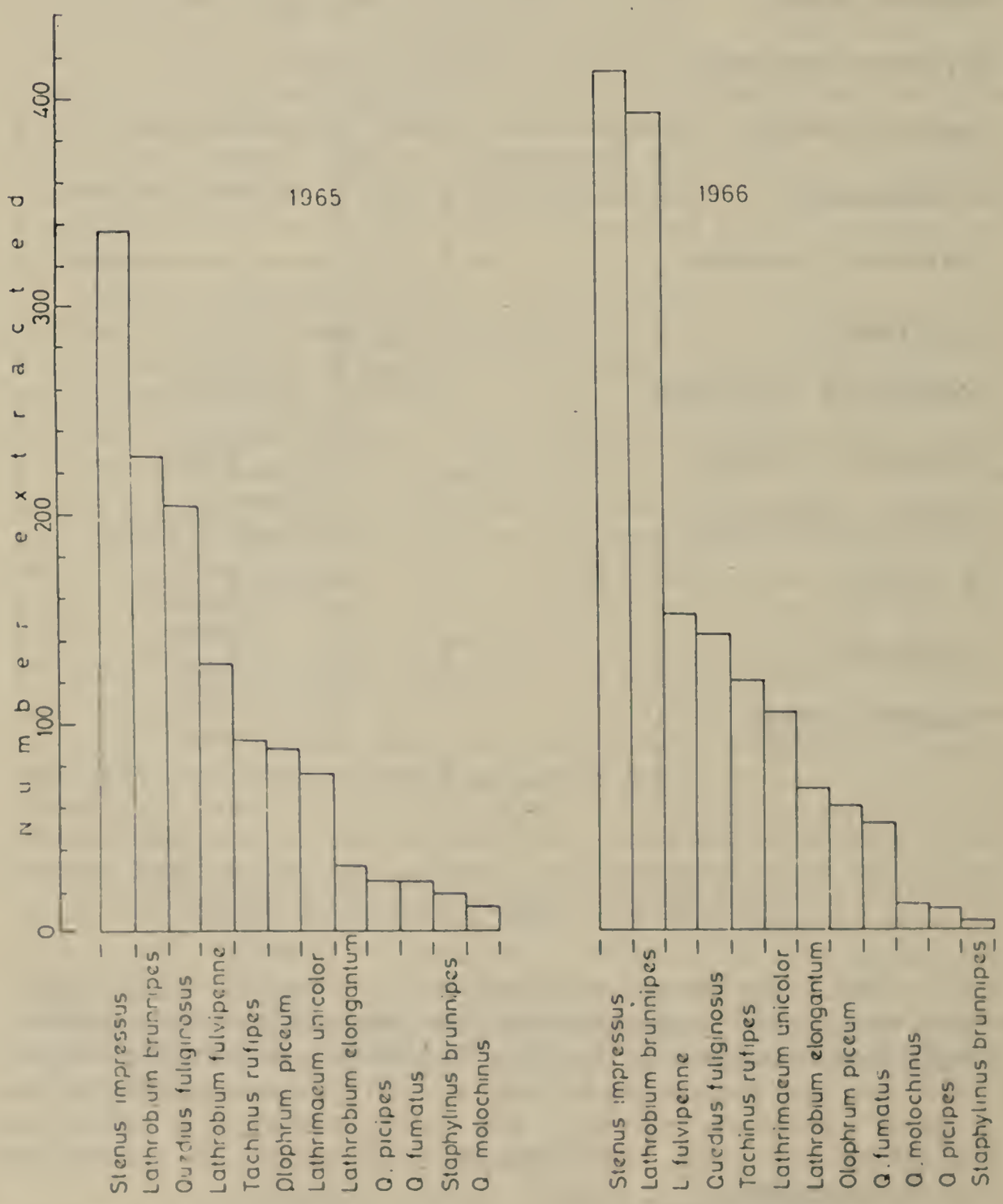

FIG. 2. Relative abundance of some Staphylinidae; bars represent the total number of adults extracted from the litter samples in a year

Group 2: Species with maximum numbers appearing during May and June: *Lathrobium elongatum* L., *Tachinus rufipes* De Geer, *Bryocharis cingulata* Mannerheim, *Quedius fumatus* Stephens, *Q. fuliginosus* Gravenhorst, *Lathrobium brunnipes* F. and *L. fulvipenne* Gravenhorst.

Group 3: Species with maximum numbers appearing between July and September: *Staphylinus brunnipes* F., *Bryocharis inclinans* Gravenhorst, *Q. molochinus* Grav., *Q. picipes* Mannerheim, *Q. lateralis* Grav., *Acidota crenata* F.

The duration of the periods during which the various species were active varied considerably. Generally, species in Group 2 were active for the longest period, followed by species in Group 1; species in Group 3 were active for a few weeks only.

B: Relative Abundance of the Species Studied

The numbers of adults caught in pitfall traps reflect fluctuations in both absolute numbers of adults within a population and also activity under varying conditions. Due to the variation in activity in different species, the numbers of a species obtained by pitfall trapping, can hardly reflect its abundance relative to other species nor the relative abundance of each species at different times of the year.

Information on the relative abundance of species studied was obtained from the results of litter sampling. The numbers of a species obtained from the leaf litter samples was considered to reflect absolute numbers of adults within a population and to provide an index of its abundance relative to the other species. Fig. 2 gives the total numbers of adults of some species extracted from the litter samples during 1965 and 1966.

C: Systematic Account of Life-Histories

Quedius fuliginosus Gravenhorst

Q. fuliginosus adults were trapped from March until November with the maximum numbers occurring during June. The results for 1965 and 1966 are given in fig. 3A. During the winter months the beetles were found in moss, especially on rocks, under stones, logs and occasionally under bark and leaf litter. In Holland, Van der Drift (1959) trapped *Q. fuliginosus* adults from March to December with the maximum numbers appearing between April and June.

The total numbers of males and females trapped during 1965 were 149 and 119 respectively, while in 1966 they were 48 and 41 respectively. A X^2 test indicated that in the former year the males were significantly ($P.<0{\cdot}1$) more represented in the traps than the females whereas in 1966, the sexes were more or less trapped in equal numbers.

Seasonal Changes in the Female Reproductive System

The result of periodic dissections of female beetles during 1965 and 1966 are recorded in Table 1. No beetles were dissected during

TABLE 1
Quedius fuliginosus: State of Ovaries during 1965 and 1966

Month	No. Dissected	No. Immature	No. Developing	No. Mature	No. Spent	Comments
January, 1965	—	—	—	—	—	
February	—	—	—	—	—	
March	5	2*	3	0	0	*With Corpora Lutea
April	6	0	5	1	0	
May	29	0	4	25	0	
June	13	0	2	11	0	
July	13	0	2	11	0	
August	3	0	0	0	3	
September	7	2t	1	1	3	t=teneral
October	10	8t	0	1	1	
November	3	1	0	0	2	
December	5	1	0	0	4	
January, 1966	1	1	0	0	0	
February	5	5*	0	0	0	*1 with Corpora Lutea
March	3	3*	0	0	0	*1 ,, ,,
April	5	4*	1	0	0	*1 ,, ,,
May	9	1	3	5	0	
June	13	0	4	9	0	
July	6	0	2	4	0	
August	2	0	0	1	1	
September	3	1t	0	0	2	
October	1	1t	0	0	0	
November	—	—	—	—	—	
December	—	—	—	—	—	

January and February 1965, but in 1966 the ovaries of the beetles dissected during these months were immature and the fat body was small. By March a few of the beetles dissected had developing eggs and a flocculent fat body. Females with mature eggs were first found in the field in April 1965 and in May 1966. A few of the beetles dissected from January to April had corpora lutea, suggesting that they had produced eggs in the previous season. In May, June and July, the majority of the beetles dissected contained mature eggs. Females with spent ovaries were first encountered in August. In spent females, the reproductive system shows corpora lutea at the base of the ovarioles, the common oviduct usually appears yellowish green and the fat body is depleted. Young females with very small whitish ovaries were dissected during September and October.

Occurrence of Larvae and Pupae in the Field

Q. fuliginosus larvae were found in the field from June until September 1965, and from June until August 1966. First and second instar larvae were trapped and extracted from the litter samples from June to August, with the maximum numbers in both instars appearing during July, while third instar larvae were trapped and extracted from the litter samples from July to September in 1965 and from July to August 1966; in the latter instar maximum numbers appeared about the first week of August.

The pupae were very difficult to find, but three pupae were found on 12.8.1965 under a log. According to Paulian (1941) pupation occurs in France about March.

Summary of Life-History

Q. fuliginosus was found at the Ross Peninsula to be a spring and a summer breeder with summer larvae. Adults come out of their overwintering sites at the beginning of spring; feed and rapidly build up food reserves. The majority of females oviposit from about the end of spring until July.

In 1965, however, a few of the females dissected in September and October were found with developing and mature eggs. It is not known whether the eggs produced by the latter females hatch and give rise to winter larvae in this area. It seems possible, however, that in warmer climates the species might be bivoltine, which would explain why Paulian found pupae in March. At the Ross Peninsula pupation begins probably during the last week of July or early in August and the new generation first appears in August.

Tachinus rufipes De Geer

This was one of the most abundant Staphylinids trapped at the Ross Peninsula. It was trapped most commonly from April until October with the maximum numbers occurring in May. The results for 1965 and 1966 are given in fig. 3B.

During the winter months the beetles were found apparently hibernating under stones, bark, decayed woods, in moss and leaf litter.

The total numbers of males and females caught during 1965 were 318 and 204 respectively, and during 1966, 568 and 506 respectively. In 1965, significantly more males were trapped than females (X^2: $P<0{\cdot}001$), whereas in 1966 the sexes were trapped in more or less equal numbers.

Seasonal Changes in the Female Reproductive System

Table 2 shows the results of periodic dissections of female beetles during 1965 and 1966. No beetles were dissected during January and February 1966, but in 1965 the beetles dissected

TABLE 2

Tachinus rufipes: State of Ovaries during 1965 and 1966

Month	No. Dissected	No. Immature	No. Developing	No. Mature	No. Spent	Comments
January, 1965	3	3	0	0	0	
February	2	2	0	0	0	
March	9	9	0	0	0	
April	13	10	2	1	0	
May	36	22	3	11	0	
June	12	2	0	10	0	
July	12	0	2	10	0	
August	9	0	0	2	7	
September	14	13t	0	0	1	t=teneral adults
October	4	4t	0	0	0	
November	4	4*	0	0	0	*With plenty of fat
December	—	—	—	—	—	
January, 1966	—	—	—	—	—	
February	—	—	—	—	—	
March	5	5	0	0	0	
April	13	9	2	2	10	
May	30	9	20	1	0	
June	20	2	11	7	0	
July	22	0	0	16	6	
August	30	14t	0	1	15	
September	10	10t	0	0	0	
October	—	—	—	—	—	
November	—	—	—	—	—	
December	—	—	—	—	—	

during these months were immature. In April most of the beetles were immature but a few had developing eggs. Thereafter, the proportion of females with mature eggs increased until about July. Spent females were, in 1965, first encountered in August, while in 1966 they were first encountered in July. Newly emerged and immature females were first found in September 1965 and August 1966.

Occurrence of Larvae in the Field

In 1965 larvae were found in the field from June until August and in 1966 from May until August. The numbers of the various instars caught in pitfall traps are given in Table 3.

Summary of Life-History

T. rufipes was found to be a spring and summer breeder with summer larvae. Adults emerge from their hibernacula during spring, and females produce eggs from the end of spring until summer. Pupation possibly starts towards the beginning or

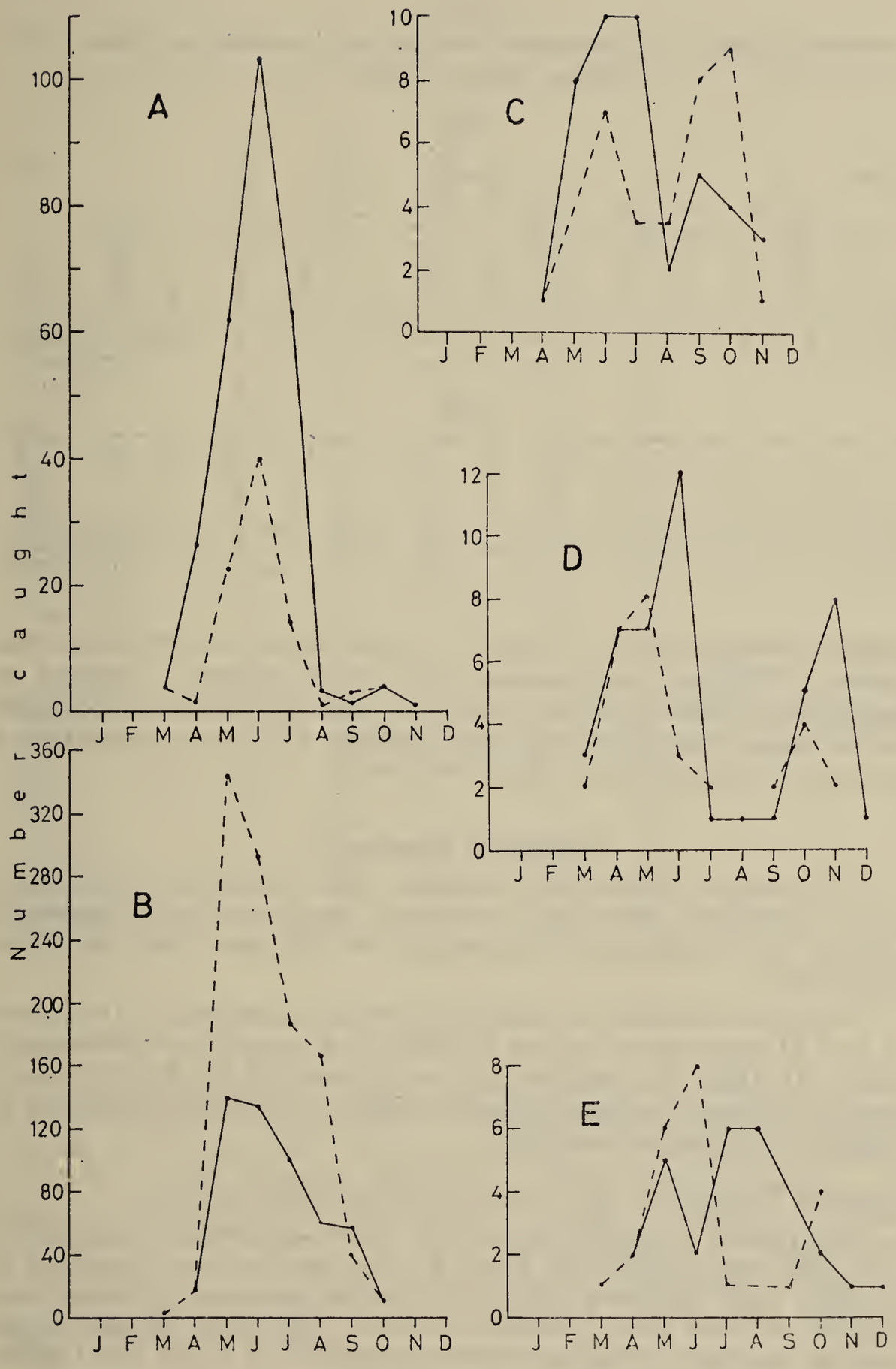

FIG. 3. Seasonal locomotor activity in some Staphylinidae; ————: 1965; — — — —: 1966; A: *Quedius fulginosus;* B: *Tachinus rufipes;* C: *Lathrobium brunnipes;* D: *L. fulvipenne;* E: *L. elongatum*

TABLE 3

Tachinus rufipes: The numbers of various instars caught in Pitfall Traps during 1965 and 1966

1965

Instar	Months												Total
	J	F	M	A	M	J	J	A	S	O	N	D	
I	0	0	0	0	0	3	3	0	0	0	0	0	6
II	0	0	0	0	0	5	19	3	0	0	0	0	27
III	0	0	0	0	0	13	101	31	0	0	0	0	145
Total	0	0	0	0	0	21	123	34	0	0	0	0	188

1966

I	0	0	0	0	0	3	2	0	0	0	0	0	5
II	0	0	0	0	0	6	5	3	0	0	0	0	14
III	0	0	0	0	0	11	31	7	0	0	0	0	49
Total	0	0	0	0	0	20	38	10	0	0	0	0	68

about the beginning of August. The larvae occur during the middle of August and teneral adults first appear in August or September. These hibernate with the gonads immature and come out to breed during the following spring. Only one generation a year was observed at the Ross Peninsula.

Lathrobium brunnipes F.

L. brunnipes adults were trapped most commonly from April until November, although occasional specimens were taken in January and February. The results for 1965 and 1966 are given in Fig. 3c.

The total numbers of males and females trapped in 1965 were 13 and 31 respectively, while in 1966 they were 20 and 16 respectively. In 1965, the females were significantly (X^2: $P<0{\cdot}01$) more numerous than the males, while in 1966 the sexes were trapped in approximately equal numbers.

Seasonal Changes in the Female Reproductive System

The results of periodic dissection of female beetles during 1965 and 1966 are recorded in Table 4. No beetles were dissected in January and February 1965, but beetles dissected during these months in 1966 had immature ovaries. By April several of the beetles dissected contained developing eggs and a few had mature eggs. In 1965, one beetle dissected in February and one dissected in April had corpora lutea indicating that they had produced eggs in the previous season. By June and July most of the beetles contained mature eggs. Spent females were first encountered in August and newly emerged females first appeared in August 1965 and in September 1966.

TABLE 4

Lathrobium brunnipes: State of Ovaries during 1965 and 1966

Month	No. Dissected	No. Immature	No. Developing	No. Mature	No. Spent	Comments
January, 1965	—	—	—	—	—	
February	—	—	—	—	—	
March	5	5	0	0	0	
April	9	1	7	1	0	
May	13	0	2	11	0	
June	10	0	3	7	0	
July	9	0	3	6	0	
August	3	1t	0	0	2	t=teneral
September	5	2t	0	0	3	
October	2	2t	0	0	0	
November	6	4	0	0	2	
December	3	2	0	0	1	
January, 1966	7	7	0	0	0	*1 with Corpora Lutea
February	4	4*	0	0	0	
March	3	3	0	0	0	*1 with Corpora
April	8	4*	1	3	0	
May	6	3	0	3	0	
June	9	0	0	9	0	
July	5	0	1	4	0	
August	5	0	0	0	5	
September	12	6t	0	0	6	
October	9	8t	0	0	1	
November	5	5	0	0	0	
December	—	—	—	—	—	

Occurrence of Larvae in the Field

The larva of *L. brunnipes* is described by Potostkaya (1965). This author gives a key which distinguishes this larva from other species of *Lathrobium* larvae including *L. fulvipenne* and *L. elongatum* both of which also occur at the Ross Peninsula. The key, however, proved so difficult to use that no attempt was made to separate the larvae of the three species found. For the present it will suffice to note that larvae of *Lathrobium* spp. occurred in the field during 1965 and 1966 from the end of May until the beginning of September.

L. fulvipenne Gravenhorst

This species was trapped most commonly from March until July and during October and November in 1965. In 1966, the pattern of activity more or less followed that of 1965 except that beetles were not trapped in August and maximum activity in 1966

occurred a month earlier. The results for 1965 and 1966 are given in Fig. 3D.

In both years males and females were trapped more or less in equal numbers (total males in 1965, 22; females, 25; total males in 1966, 17; females, 15).

Seasonal Changes in the Female Reproductive System

The changes in the female reproductive system are similar to those of *L. brunnipes* except that in *L. fulvipenne* females with mature eggs occurred in the field a month earlier, i.e., March.

L. elongatum L.

This was the least abundant of the species of *Lathrobium* found at the Ross Peninsula (fig. 2). Adults were most commonly trapped from April until October. The results for 1965 and 1966 are shown in fig. 3E.

Seasonal Changes in the Female Reproductive System

The changes in the female reproductive system are similar to those of *L. fulvipenne*.

Summary of Life-Histories of Lathrobium spp.

Although the last two species appear to produce eggs earlier in the year, all three species of *Lathrobium* appear to be spring and summer breeders with summer larvae. Pupation is thought to begin towards the middle of summer and the new generation to appear from July onwards. (In *L. fulvipenne* teneral adults were first recorded in July in 1965.) The new generation overwinters with the gonads immature and comes out to breed early in spring.

Bryocharis cingulata Mannerheim

B. cingulata was trapped only in very small numbers from April and August in 1965 and during May and June in 1966. It was extremely rare in the litter samples; only three specimens extracted in June 1965 were obtained. The results from pitfall trapping throughout 1965 and 1966 are recorded in Table 5.

Dissection of Female Beetles

Only a few beetles were available for dissection. In 1965, four females were dissected between May and June and all of them contained mature eggs. In 1966, two specimens were dissected in May and three in June; all of them had mature eggs.

Occurrence of Larvae in the Field

Very few larvae were obtained by pitfall trapping and leaf litter sampling. In 1965, they were found in the field between June and July and in 1966 between May and July.

TABLE 5

Bryocharis cingulata: The numbers of Adults Caught in Pitfall Traps during 1965 and 1966

Year	Sex	Months J	F	M	A	M	J	J	A	S	O	N	D	Total
1965	♂	0	0	0	1	3	5	0	1	0	0	0	0	10
	♀	0	0	0	1	2	2	0	0	0	0	0	0	5
	Total	0	0	0	2	5	7	0	1	0	0	0	0	15
1966	♂	0	0	0	0	7	1	0	0	0	0	0	0	8
	♀	0	0	0	0	2	2	0	0	0	0	0	0	4
	Total	0	0	0	0	9	3	0	0	0	0	0	0	12

Life-History

Although only a few specimens were available for study, the data suggest that *B. cingulata* is a spring and summer breeder with summer larvae. It is not known when the new generation appears.

Drymoporus elongatus Gyllenhal

Like the preceding species, *D. elongatus* was trapped in small numbers. No specimen was extracted from the litter samples during the two years of study. In 1965, adults were trapped from May until July with the greatest numbers appearing during June; while in 1966, they were trapped in July and August only. The results for 1965 and 1966 are recorded in Table 6.

TABLE 6

Drymoporus elongatus: The number of Adults Caught in Pitfall Traps during 1965 and 1966

Year	Sex	Months J	F	M	A	M	J	J	A	S	O	N	D	Total
1965	♂	0	0	0	0	3	13	5	0	0	0	0	0	21
	♀	0	0	0	0	1	10	1	0	0	0	0	0	12
	Total	0	0	0	0	4	23	6	0	0	0	0	0	33
1966	♂	0	0	0	0	0	2	0	0	0	0	0	0	2
	♀	0	0	0	0	0	3	1	0	0	0	0	0	4
	Total	0	0	0	0	0	5	1	0	0	0	0	0	6

Dissection of Female Beetles

Female beetles were dissected from May until July in 1965 and during July and August in 1966. In May the ovaries were immature, but by June some of the beetles dissected contained developing eggs. Gravid females were found in the field in July and August.

The larva of *D. elongatus* is unknown.

Life-History

The data obtained by pitfall trapping and dissections of female beetles appear to suggest that *D. elongatus* is a summer breeder, probably with summer or autumn larvae. It is not known when the new generation appears.

Staphylinus brunnipes F.

The adults of this species were trapped most commonly from the end of May until the end of September with the greatest numbers appearing in July. The results for 1965 and 1966 are given

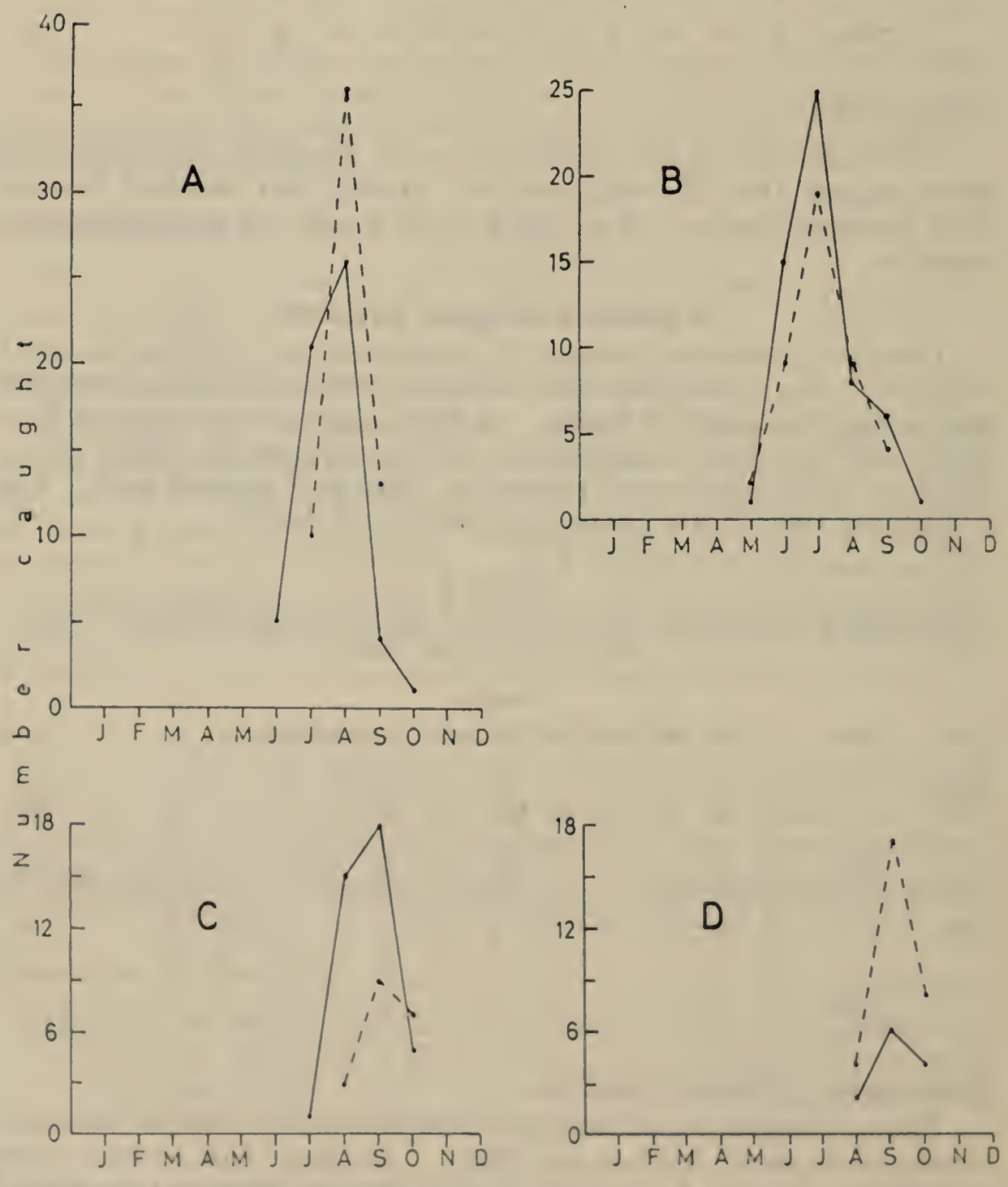

FIG. 4. Seasonal locomotor activity in some Staphylinidae; ————: 1965; – – – –: 1966; A: *Quedius molochinus;* B: *Staphylinus brunnipes;* C: *Quedius picipes;* D: *Q. lateralis*

in Fig. 4B. In Holland, Van der Drift (1959) trapped *S. brunnipes* adults from March until September, but occasional specimens were taken by him in October and November; the greatest numbers were taken during June.

The total numbers of males and females trapped in 1965 were 47 and 15 respectively and in 1966, 36 and 8 respectively; the preponderance of the males in the traps over the females being highly significant (X^2: $P<0{\cdot}001$) in both years.

Dissection of Female Beetles

Very few females were available for dissection. In April and May the ovaries were immature. By June most of them contained developing eggs and gravid females were found towards the end of June and in July.

Occurrence of Larvae in the Field

The larva of *S. brunnipes* is as yet undescribed; the probable larva, however, will be discussed elsewhere. In Table 7, records from leaf litter samples are summarised showing the months when various instars of this larva were found in the field. The larvae were not caught in pitfall traps.

TABLE 7

Staphylinus brunnipes (probable larva): The number of larvae extracted from the litter samples during 1965-1966

Month	INSTAR I	II	III	Total
January, 1965	0	0	1	1
August	1	0	0	1
October	0	2	1	3
December	0	0	1	1
Total for 1965	1	2	3	6
September, 1966	2	3	0	5
October	0	1	1	2
November	0	0	0	0
December	0	0	0	0
Total for 1966	2	4	1	7

Life-History

The life-history of *S. brunnipes* cannot easily be worked out from the available data. Nevertheless, the information obtained from pitfall trapping and dissection of female beetles, seems to suggest that this species is a summer breeder. If the larvae taken in the leaf litter samples are those of *S. brunnipes,* then the species has winter larvae; that is, the larvae overwinter and pupate in spring or early summer of the following year. In Holland, Van der Drift (1959) states that *S. brunnipes* has both summer and winter larvae, but he was not certain whether the new generation appears

in autumn or in spring of the following year. He considered the latter possibility to be the most likely one.

Stenus impressus Germar

Pitfall trapping was found unsuitable for this Staphylinid. In 1965, only two adults were obtained by this method (in September) and in 1966 one adult was caught in August and two in September. Van der Drift (1951) observed small Carabidae e.g. *Notiophilus* spp. to cling to the edge of the trap and return, thereby evading capture. Although this was not observed in *S. impressus*, it is probable that it might have evaded capture in the same way or possibly by sight since it has big eyes.

The following account is based on data obtained by leaf litter sampling. The results of sampling from March 1965 to December 1966 are given in fig 5.

Seasonal Changes in the Female Reproductive System

The results obtained by dissecting female beetles during 1965 and 1966 are summarised in table 8. From January to May the

TABLE 8

Stenus impressus: State of Ovaries during 1965 and 1966

Month	No. Dissected	No. Immature	No. Developing	No. Mature	No. Spent	Comments
January, 1965	—	—	—	—	—	
February	—	—	—	—	—	
March	4	4	0	0	0	
April	10	10	0	0	0	
May	3	3	0	0	0	
June	1	1	0	0	0	
July	13	0	4	9	0	
August	3	0	1	2	0	
September	13	0	2	11	0	
October	11	4t	0	4	3	t = teneral
November	6	4t	0	0	2	
December	4	2t	0	0	2	
January, 1966	4	4*	0	0	0	*1 teneral
February	4	4	0	0	0	
March	6	6	0	0	0	
April	6	6	0	0	0	
May	7	7	0	0	0	
June	5	2	3	0	0	
July	6	0	3	3	0	
August	2	0	0	2	0	
September	6	1	1	4	0	
October	7	3*	1	3	0	*1 teneral
November	1	1t	0	0	0	
December	—	—	—	—	—	

ovaries were immature, by June some of the beetles dissected contained developing eggs. Gravid females were found from July until October and spent females between October and December; spent females were not found in 1966. Newly emerged adults first appeared during October.

Occurrence of Larvae in the Field

Larvae were obtained from leaf litter samples only. They were found only in small numbers from September 1965 until January 1966 and also during the period September to December 1966. The results are summarised in table 9.

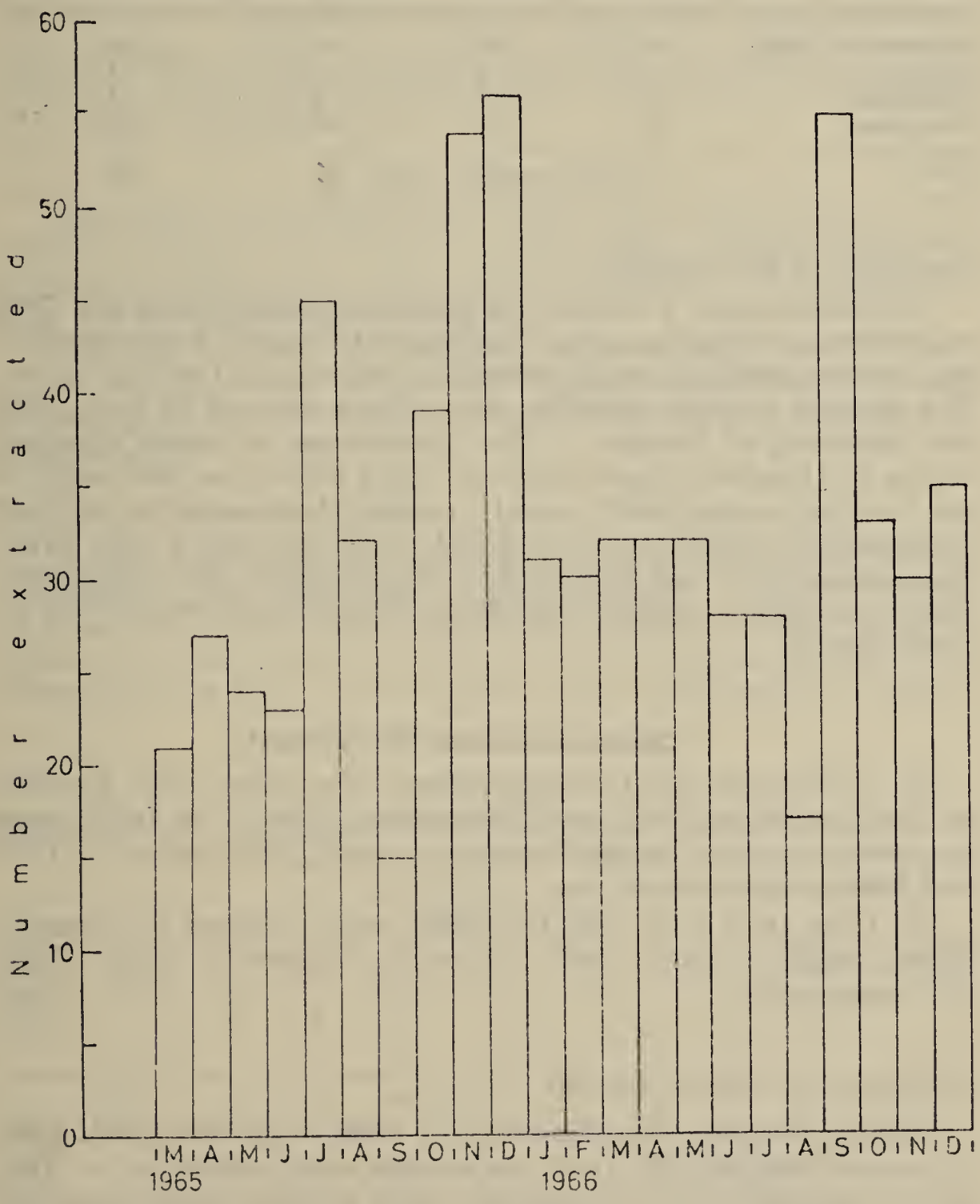

FIG. 5. *Stenus impressus;* the number of adults extracted from the litter samples each month during 1965 and 1966

TABLE 9

Stenus impressus: The Number of Larvae Extracted from the Litter Samples during 1965 and 1966

Month	INSTAR I	II	III	Total
September, 1965	2	1	1	4
October	0	1	0	1
November	0	1	4	5
December	0	0	0	0
January, 1966	0	0	2	2
Total	2	3	7	12
September, 1966	3	2	0	5
October	2	4	5	11
November	0	1	3	4
December	0	2	10	12
Total	5	9	18	32

Summary of Life-History

The information provided by dissecting females and the data on occurence of larvae in the field indicate that *S. impressus* is a late summer and autumn breeder with autumn and winter larvae. The females oviposit probably from about the end of July until the beginning of October. The appearance of newly emerged adults in October suggests that the eggs which are laid early in the breeding season hatch quickly, possibly because of the warmer temperature of autumn, go through both the larval and pupal stages rapidly so that by October new imagines start appearing. Those eggs which are laid later in the breeding season give rise to winter larvae.

Quedius molochinus Gravenhorst

Q. molochinus adults were trapped from June until October in 1965 and from July until September 1966. In both years maximum numbers occurred during August. The results for 1965 and 1966 are given in fig. 4a.

In both 1965 and 1966 the sexes were trapped in approximately equal numbers (1965: males 29; females 27, 1966: males 26; females 33).

Dissection of Female Beetles

Female beetles were dissected in both 1965 and 1966, from June until October. In June, the ovaries were immature, by July and, in August and in September most of the beetles dissected contained mature eggs. Spent females were first encountered in October.

Occurrence of Larvae in the Field

Q. molochinus larvae were found in the field from September 1965 until January 1966 and also during the period September to December 1966. First instar larvae were found during September and October, second instar larvae were found during September and October and third instar larvae from October onwards.

Summary of Life-History

Q. molochinus is a late summer and autumn breeder. The beetles are active from about the middle of summer until about the end of October. Oviposition occurs between July and September and the larvae were found in the field from September until January. The new generation emerges in spring or early summer. (A soft newly emerged beetle was sieved from the leaf litter at the beginning of June 1966.)

Q. picipes Mannerheim

This species was trapped from July until October during 1965 and from August until October during 1966. In both years the maximum numbers appeared during September. The results for 1965 and 1966 are given in Table 4c.

The total numbers of males and females caught in 1965 were 27 and 14 respectively and in 1966 11 and 8 respectively. In 1965 the preponderance of the males in the traps over the females was significant (X^2 : $P<0.01$).

Dissection of Female Beetles

In 1965 female beetles were dissected from April until November while in 1966 from May until November. All the beetles dissected from April until July had immature ovaries. In 1965 some of the beetles dissected during this period had corpora lutea indicating that they had produced eggs in the previous season.

TABLE 10

Quedius picipes: The number of Larvae Extracted from the Leaf Litter Samples during 1965 and 1966

Year	Instar	Months A	S	O	N	D	J	F	M	Total
1965/	I	0	1	4	3	0	0	0	0	8
1966	II	0	0	0	5	4	0	0	0	9
	III	0	0	0	0	4	7	4	0	15
	Total	0	1	4	8	8	7	4	0	32
	I	0	2	10	5	0	Observations			17
1966	II	0	1	3	7	2	Terminated			13
	III	0	0	0	4	5				9
	Total	0	3	13	16	7				39

Females with developing eggs were first found in the field in August. Gravid females occurred from September until November.

Occurrence of Larvae in the Field

Q. picipes larvae were very rare in pitfall traps; only one specimen in the first instar was taken (in October 1965) during the two years of study. They were, however, extracted in small numbers from the litter samples from September 1965 until February 1966 and during the period September to December 1966. The results for 1965 and 1966 are give in Table 10.

Summary of Life-History

The life-history of *Q. picipes* is similar to that of *Q. molochinus* except that in *Q. picipes*, breeding starts a little later in the season.

Q. *lateralis* Gravenhorst

Q. lateralis was trapped from August until October, with the greatest numbers appearing in September. The results for 1965 and 1966 are given in fig. 4D. Beetles were extremely rare in the litter samples; only two specimens (taken in September 1965) were obtained during the two years of study.

In Holland, Van der Drift (1959) trapped adults of this species in small numbers during spring and summer and most commonly from the end of August until the middle of October. The greatest numbers occurred during September.

In both 1965 and 1966, females were more frequent in the traps than males. (1965: males 4; females 8; 1966: males 12; females 17).

Dissection of Females

Only a few females were available for dissection. Females with mature ovaries were found from the end of August until October. A couple of specimens dissected in May 1965 had corpora lutea suggesting that they had produced eggs in the previous season.

The Larvae

Q. lateralis larvae were neither trapped nor obtained from the litter samples during 1965. In 1966, however, three first instar larvae and one second instar larva were trapped in October, and one second instar larva was trapped in November. Only two larvae, a first instar taken in October and a third instar taken in December, were obtained from the litter samples during 1966.

From January until March 1965, several third instar larvae were collected under logs from a wood at Bothwell near Uddingston, Lanarkshire.

Life-History

Although only a few specimens were studied, the information obtained by trapping adults, dissecting females and collecting larvae indicates that *Q. lateralis* is an autumn breeder with winter larvae. The new generation probably appears in spring and in early summer a newly emerged adult was collected from Bothwell during 1965.

In Holland, Van der Drift (1959) found this species to have winter larvae.

Bryocharis inclinans Gravenhorst

B. inclinans adults were trapped only in small numbers. They were most commonly trapped from June until September but occasional specimens were taken at other times of the year. The results of trapping adults throughout 1965 and 1966 are recorded in table 11.

B. inclinans was not obtained from the litter samples.

TABLE 11

Bryocharis inclinans: The number of Adults Caught in Pitfall Traps during 1965 and 1966

		Months												
Year	Sex	J	F	M	A	M	J	J	A	S	O	N	D	Total
1965	♂	0	0	1	0	0	0	0	2	2	0	0	1	6
	♀	0	0	0	0	0	0	2	1	1	0	2	0	6
	Total	0	0	1	0	0	0	2	3	3	0	2	1	12
1966	♂	1	1	1	0	0	0	2	4	0	4	1	0	14
	♀	0	0	0	1	0	0	4	2	0	0	0	0	7
	Total	1	1	1	1	0	0	6	6	0	4	1	0	21

Dissection of Female Beetles

Very few beetles were available for dissection. In July the beetles contained immature ovaries. In August 1965, one beetle was dissected and found to contain developing eggs; in September, the single specimen dissected was mature, no beetles were dissected in October 1965 but the two beetles dissected in November were mature. In 1966, only two beetles were dissected (in August) and found to contain developing eggs.

The larva of *B. inclinans* is unknown.

Life-History

The information provided by trapping adults and dissection of females suggests that *B. inclinans* is an autumn breeder.

Acidota crenata F.

As in the preceding species *A. crenata* was trapped in small numbers; it was trapped during September and October only. The results for 1965 and 1966 are give in Table 12.

TABLE 12

Acidota crenata: The Number of Adults Caught in Pitfall Traps in 1965 and 1966

Year	Sex	Months A	S	O	N	D	Total
1965	♂	0	6	2	0	0	8
	♀	0	4	1	0	0	5
	Total	0	10	3	0	0	13
1966	♂	0	1	0	0	0	1
	♀	0	0	2	0	0	2
	Total	0	1	2	0	0	2

The species was rare in the litter samples; two specimens taken in August 1965 were obtained during the two years of study.

Dissection of Female Beetles

In September, 1965, three of the four females dissected contained developing eggs, the other was immature, in October one specimen was dissected and found with mature eggs. In 1966, two beetles were dissected in October and found to contain mature eggs.

The larva of *A. crenata* is unknown.

Life-History

Although only a few specimens were available for study the data obtained suggest that *A. crenata* is an autumn breeder. It is not known when the new generation appears.

Lesteva heeri Fauvel

This species was trapped in very small numbers. It was trapped during autumn, winter and spring with the maximum numbers occurring in spring.

No beetles were obtained from the litter samples.

Dissection of Female Beetles

In 1965, beetles were dissected from January to March and during November and December; they were sieved from moss especially in wet places. In January the beetles contained mature eggs; In February one of the three beetles dissected contained mature eggs and the rest were spent. In March, five beetles were

dissected, two of these were spent and the rest were newly emerged imagines. Two females were dissected in November and one in December; all of them contained eggs. In 1966, beetles were dissected from February until April. Altogether seven specimens sieved from moss were dissected during this period; all of them were newly emerged imagines.

Occurrence of Larvae in the Field

FIG. 6. Seasonal locomotor activity in A: *Olophrum piceum*; B: *Lathrimaeum unicolor*

The larvae of *L. heeri* were extremely rare in both pitfall traps and litter samples. They were, however, sieved from moss especially in wet places from December, 1965, to the beginning of May, 1966.

Summary of Life-History

The information provided by dissection of beetles and collection of larvae from the field shows that *L. heeri* is an autumn and winter breeder. The larvae occur during winter and the new generation first appears about the end of February or in March.

Olophrum piceum Gyllenhal

O. piceum adults were trapped from September until May with the maximum numbers appearing in October or November. Thereafter, activity declined and by January very few specimens were caught. However, an increase in activity was recorded during March. The results of trapping from January, 1965, to December, 1966, are given in fig. 6A.

TABLE 13

Olophrum piceum: State of Ovaries during 1965 and 1966

Month	No. Dissected	No. Immature	No. Developing	No. Mature	No. Spent	Comments
January, 1965	3	3t	0	0	0	t=teneral
February	12	12t	0	0	0	
March	18	18t	0	0	0	
April	12	12	0	0	0	
May	4	4	0	0	0	
June	—	—	—	—	—	
July	8	8	0	0	0	
August	—	—	—	—	—	
September	7	0	1	6	0	
October	16	0	3	13	0	
November	8	0	0	8	0	
December	5	0	0	4	1	
January, 1966	3	2t	0	0	1	
February	3	3t	0	0	0	
March	7	7t	0	0	0	
April	8	8	0	0	0	
May	—	—	—	—	—	
June	—	—	—	—	—	
July	1	1	0	0	0	
August	—	—	—	—	—	
September	2	0	2	0	0	
October	21	1	7	13	0	
November	12	0	0	12	0	
December	10	0	0	10	0	

The total numbers of males and females caught between September, 1965 and May, 1966, were 108 and 80 respectively; this difference is significant (X^2: $P<0{\cdot}05$).

Seasonal Changes in the Female Reproductive System

The results of dissection of female beetles during 1965 and 1966 are given in Table 13. Almost all the beetles dissected beween January and March were newly emerged imagines and had soft lightly coloured bodies and no fat reserve. One specimen, dissected in January, 1966, had spent ovaries. In April and May they had immature ovaries, and a flocculent fat body. Females with developing and mature eggs first appeared in September. By October, the majority, and by December almost all females contained mature eggs.

Occurrence of Larvae and Pupae in the Field

O. piceum larvae were found in the field from October to the beginning of March. First instar larvae were found from October until November; second instar larvae from October to December and third instar larvae from November until March.

Pupae were found in the field from about the last week of December, 1965, until the end of March, 1966. They were found most commonly under wet moss especially on rocks and under logs and stones.

Summary of Life-History

O. piceum is an autumn and winter breeder. Adults become active at the beginning of autumn and produce eggs in autumn and the first half of winter. The peak of activity recorded in October is possibly due to breeding activity. The larvae occur in autumn and winter and pupation begins about the end of December. The new generation first appears in January and reaches its maximum numbers in March. The peak of activity recorded in March is due to emergence of the new generation. After this peak the beetles disappear and spend the summer aestivating in the leaf litter. (Adults were found in the litter samples throughout summer).

Lathrimaeum unicolor Marsham

L. unicolor adults were trapped from October until May during the 1965/66 season with the greatest numbers appearing during April. The results of trapping adults from January, 1965, to December, 1966, are given in Fig. 6B.

The total numbers of males and females caught during the 1965/66 season were 54 and 33 respectively; this difference is significant (X^2: $P<0{\cdot}05$).

Seasonal Changes in the Female Reproductive System

The results of dissection of female beetles during 1965 and 1966 are given in Table 14. In January and February, 1965, a few

TABLE 14

Lathrimaeum unicolor: State of Ovaries during 1965 and 1966

Month	No. Dissected	No. Immature	No. Developing	No. Mature	No. Spent	Comments
January, 1965	14	11t	0	1	2	t=teneral
February	8	1t	0	2	5	*3 teneral
March	4	4t	0	0	0	
April	34	34t	0	0	0	
May	3	3	0	0	0	
June	—	—	—	—	—	
July	6	6	0	0	0	
August	—	—	—	—	—	
September	1	1	0	0	0	
October	5	0	2	3	0	
November	11	0	0	11	0	
December	5	0	0	5	0	
January, 1966	5	3t	0	0	2	
February	—	—	—	—	—	
March	4	4t	0	0	0	
April	6	6*	0	0	0	
May	7	7	0	0	0	
June	—	—	—	—	—	
July	1	1	0	0	0	
August	1	1	0	0	0	
September	3	1	2	0	0	
October	4	2	1	1	0	
November	8	0	0	8	0	
December	5	0	0	5	0	

beetles had mature and spent ovaries and the majority were teneral adults. In 1966 no mature beetles were found during this period. From March until September all the beetles dissected in both years had immature ovaries. The immature beetles in March and April had a small fat body or none, from May onwards all the beetles dissected had a flocculent fat body. Beetles with developing eggs were found in September, 1966. The single specimen dissected in September, 1965, was immature. By November all the beetles dissected contained mature eggs.

Occurrence of Larvae and Pupae in the Field

L. unicolor larvae were found in the field from November until March. First instar larvae were found from November to February, second instar larvae from November to March and third instar larvae from December to March.

Pupae were first recorded at the beginning of January 1966 and were found in the field until the end of April. As in the preceding species they were found under moss on rocks and under stones and logs.

Summary of Life-History

L. unicolor is an autumn and winter breeder. Adults become active in October and oviposit until about January. The larvae occur in the field throughout the winter and pupation starts at about the beginning of January. The new generation first appears in January and reaches its maximum numbers in April. Thereafter the beetles disappear and spend the summer aestivating in the leaf litter.

Quedius fumatus Stephens

Q. fumatus adults were uncommon at the Ross Peninsula and no more than three beetles a month were trapped during 1965. In 1966, the beetles were even less common. The results of trapping adults during 1965 and 1966 are given in Table 15.

TABLE 15

Quedius fumatus: The number of Adults Caught in Pitfall Traps during 1965 and 1966

		Months												
Year	Sex	J	F	M	A	M	J	J	A	S	O	N	D	Total
1965	♂	0	0	0	3	1	1	0	0	2	0	0	0	7
	♀	1	1	2	0	0	2	2	0	1	0	0	0	9
	Total	1	1	2	3	1	3	2	0	3	0	0	0	16
1966	♂	0	0	0	0	1	1	0	1	1	0	0	0	4
	♀	0	0	0	0	1	0	0	0	0	0	0	0	1
	Total	0	0	0	0	2	1	0	1	1	0	0	0	5

Dissection of Female Beetles

In 1966, beetles were very rare, only four specimens were dissected, one in May and three during August; all of them contained mature eggs. In 1965, however, the beetles were dissected in most months except February, August and September. With the exception of a single teneral specimen found in June, all the beetles dissected contained mature eggs.

Occurrence of Larvae in the Field

Q. fumatus larvae were not caught in pitfall traps; they were, however, obtained in small numbers from the litter samples in most months. The numbers of the various instars extracted from the litter samples each month during 1965 and 1966 are summarised in Table 16.

TABLE 16

Q. fumatus: The number of Larvae Extracted from Litter Samples during 1965 and 1966

Year	Instar	Months J	F	M	A	M	J	J	A	S	O	N	D	Total
1965	I	—	—	0	3	2	0	1	1	0	0	6	3	16
	II	—	—	0	0	0	0	0	0	0	1	0	1	2
	III	—	—	2	0	0	0	1	0	0	1	1	2	7
	Total	—	—	2	3	2	0	2	1	0	2	7	6	25
1966	I	0	0	0	0	5	0	1	0	5	5	3	2	21
	II	3	0	0	0	0	0	0	0	0	0	2	3	8
	III	9	0	0	2	0	0	0	0	0	0	1	2	14
	Total	12	0	0	2	5	0	1	0	5	5	6	7	43

Life-History

On account of the small number of specimens studied the life-history of *Q. fumatus* remains obscure. The occurrence of larvae in the field in most months would suggest that this species breeds throughout the year, but it is equally possible that a proportion of the population may breed during spring and summer and another proportion in the autumn.

D: Discussion

1. *Classification of Life-History Types*

In a study of the bionomics of Danish Carabidae, Larsson (1939) divided the Carabidae into spring and autumn breeders. According to this author, nearly all adults die after breeding so that the spring breeding species only hibernate or overwinter as new imagines. In the autumn breeding species, the adults may survive the winter but die in spring or summer before the new generation emerges. Lindroth (1945-49), also distinguished the same types of life-histories among the Scandinavian Carabidae, but he denoted them adult and larvae overwintering species respectively

In Holland, Van der Drift (1959) followed the activities and the life-histories of several Carabidae and some Staphylinidae for five years. Although he found the distinctions between spring breeding and autumn breeding species to hold good for most of the Netherland Carabidae, he noted that some of the spring breeding species survived the winter and became active the following year; several individuals of *Feronia oblongopunctata* (F.) marked by him during the breeding season were recaptured the following year. Also various workers, including Gilbert (1956), Greenslade (1965) and Penney (1965) have shown that some autumn breeding species survive the winter, spring and summer and become active the following autumn. This feature was

observed among several species of the Staphylinidae studied at the Ross peninsula.

Van der Drift, therefore, called the spring and autumn breeding species, species with summer and winter larvae respectively. His distinctions are followed here to clarify the life-history types of the Staphylinidae presented in this paper. The classification is given in Table 17.

TABLE 17

Classification of Life-History Types

Species with Summer Larvae	Species with Winter Larvae	Species with Autumn and Winter Larvae	Species with Larvae for a greater part of or throughout the Year
Philonthus decorus†	Staphylinus brunnipes		Quedius fumatus?
Quedius fuliginosus	S. erythropterus**	Stenus impressus	Othius punctulatus
Lathrobium brunnipes	Quedius molochinus		O. myrmecophilus
L. elongatum	Q. picipes		
L. fulvipenne	Q. lateralis		
Tachinus rufipes	Bryocharis inclinans?		
Drymoporus elongatus?	Acidota crenata?		
Bryocharis cingulata	Olophorum piceum		
Philonthus splendenes*	Lathrimaeum unicolor		
P. proximus*	Lesteva heeri		
P. fimetarius*	Phaganthus caraboides**		
P. marginatus*	Tachinus pallipes**		
P. puella*			
Ontholestes tessellatus*			
Megarthrus denticollis*			

†A detailed account of the bionomics of this species is in preparation.

*Females of these captured in the field laid eggs in June; the eggs hatched.

**Adults were rare but their larvae were taken in winter.

(a) *Species with Summer Larvae*

In most species oviposition occurs between mid-spring and summer, but with a few species e.g. *Lathrobium* spp., oviposition starts in early spring. The larvae occur throughout summer and emergence of the new generation takes place in late summer or early autumn. This overwinters or hibernates during winter and comes out to breed the following spring.

(b) *Species with Winter Larvae*

Most of the species with this type of life-history oviposit between late summer and mid-autumn. The larvae live in autumn,

winter and spring and emergence of the new generation occurs in spring or early summer. In *O. piceum*, *L. unicolor* and possibly *L. heeri*, however, oviposition occurs between mid and late autumn and the first half of winter. The larvae occur from late autumn until the beginning of spring but the new generation first appears about January. The adults pass the summer aestivating in leaf litter or under stones and bark.

(c) *Species with Autumn and Winter Larvae*

Only *Stenus impressus* was found to have this type of life-history. The larvae from the early laid eggs appear to mature quickly and give rise to adults in autumn of the same year. Those from the late laid eggs have a slower development; they occur throughout winter and give rise to adults possibly at the beginning of spring.

A similar life-history is reported by Greenslade (1965) for the Carabids *Harpalus rufipes* and *Abax parallelopipedus*, species with mainly winter larvae but in which some of the larvae give rise to adults in the autumn of the same year.

(d) *Species with Larvae for a greater part of or throughout the Year*

This type includes *Othius punctulatus*, *O. myrmecophilus* and possibly *Q. fumatus*. A discussion of the life-histories of the former two Staphylinids will be published elsewhere. The data for *Q. fumatus* were so meagre that its inclusion here must be tentative.

2. *Life-History Types and Locomotor Activity*

It was noted in Section A (Locomotor Activity) that in most Staphylinidae studied at the Ross Peninsula, locomotor activity was limited to a part of the year. Within this period of activity there was a considerable variation in its intensity. In almost all the Staphylinidae studied, maximum activity occurred during the oviposition period: breeding activity. A similar behaviour also occurs in Carabidae, Van der Drift (1959), Greenslade (1965).

In species with summer larvae, locomotor activity usually begins about the beginning of spring, reaches a maximum peak in May and June when females are producing eggs and gradually declines thereafter. In some species a second but lower maximum occurs during autumn. This is mainly due to the emergence of the new generation, although beetles of the old generation may be found in small numbers.

Considering species with winter larvae, the beginning of activity varies considerably from June to October. Similarly the times when the various species reach their maxima also varies considerably (figs. 1 Groups 1 and 3). In most species (Group 3) locomotor activity occurs for only a few months so that by end October only a few individuals are active. Maximum activity

occurs when females are producing eggs. In *O. piceum* and *L. unicolor* (Group 1), activity continues for a longer period, and shows two distinct maxima. A first maximum due to breeding activity in autumn and a second one due to the emergence of the new generation in spring (see fig. 6).

Summary

The life-histories of some British Staphylinidae were studied mainly by pitfall trapping and dissection of female beetles. Additional information was obtained by leaf litter sampling and by collecting larvae from the field.

Information on the relative abundance of some Staphylinids studied was provided by data obtained by leaf litter sampling, while information on the annual distribution of locomotor activity was obtained from pitfall trapping results. It was found that in most species activity was limited to a part of the year. Three seasonal groups of species were distinguished, namely:

Group 1 Species with maximum numbers appearing during March and April, e.g. *Lathrimaeum unicolor.*

Group 2 Species with maximum numbers appearing during May and June, e.g. *Tachinus rufipes.*

Group 3 Species with maximum numbers appearing between July and September, e.g. *Staphylinus brunnipes, Quedius molochinus.*

Four life-history types were distinguished amongst the Staphylinidae studied :

1 *Species with Summer Larvae* : These are active from spring until autumn. Eggs are usually laid between late spring and mid summer and the larvae occur throughout summer. The new generation usually begins to appear in August. This over-winters or hibernates with the gonads immature.

2 *Species with Winter Larvae* : The majority are active between the end of July and the end of October, while some are active betwen October and May. Whereas in the majority oviposition occurs from summer to mid-autumn; in some species e.g. *Olophrum piceum,* it starts in autumn and continues until December or until January.

The larvae live throughout the winter and the new generation appears usually between spring and early summer. In some species, however, e.g. *Olophrum piceum* the new generation first appears at the end of December or in January.

3 *Species with Autumn Larvae*: Oviposition occurs between late summer and autumn and the larvae are found from the end of summer until January. Larvae from early laid eggs give rise to adults in the autumn of the same year whereas those from later laid eggs give rise to adults around early spring. Only *Stenus impressus* was found to have this type of life-history.

4 *Species with Larvae for a greater part of or throughout the year*: These include *Othius punctulatus* and *O. myrmecophilus*, for which a detailed discussion of their life-histories will be published elsewhere and, also *Q. fumatus*. The inclusion of the latter species is tentative since very few specimens were available for study.

Acknowledgments

This study was carried out in the Department of Zoology, Glasgow University, while I was holding a grant from the British Ministry of Overseas Development. I am grateful to Dr. C. M. Yonge, C.B.E., F.R.S. (former Regius Professor of Zoology) and Professor D. R. Newth for the facilities put at my disposal during the course of this study. I am indebted to Dr. R. M. Dobson and Dr. R. A. Crowson for helpful comments and advice.

The receipt of a scholarship from the Ministry of Overseas Development is gratefully acknowledged.

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